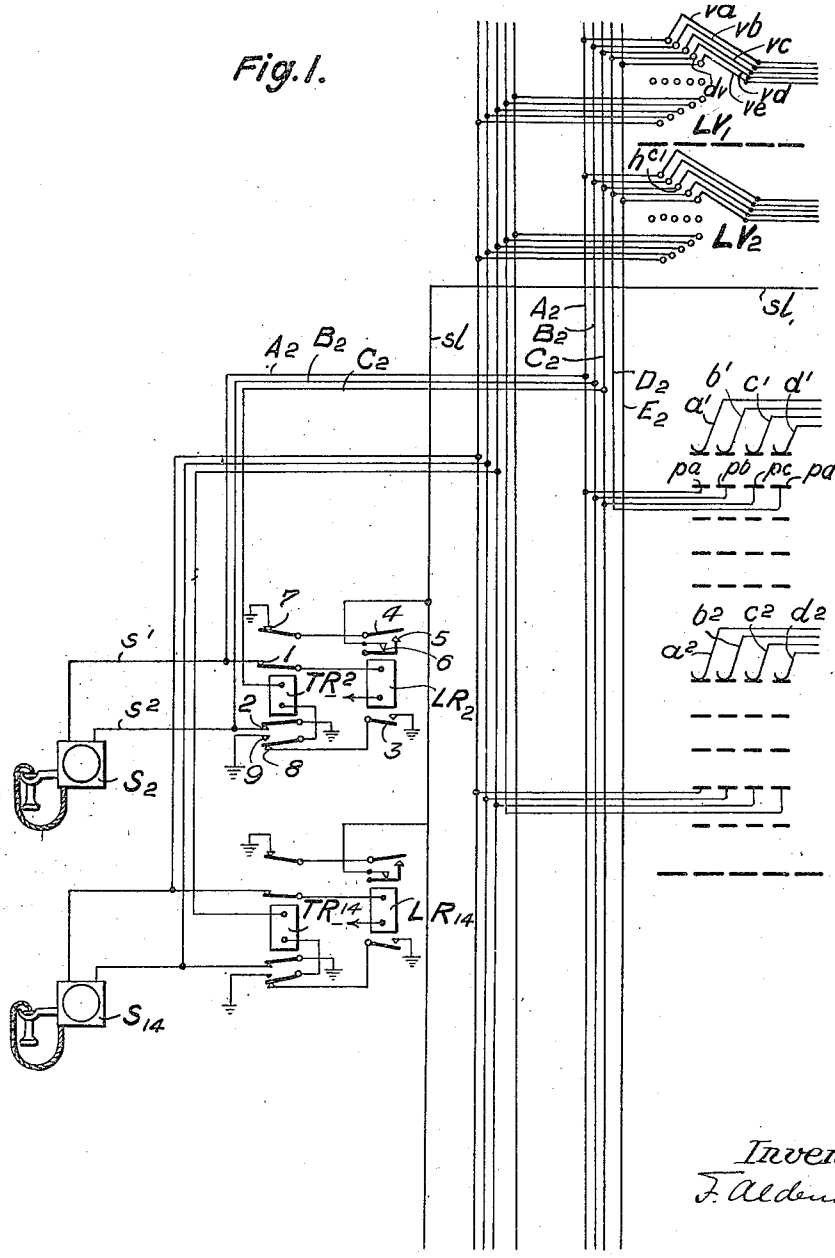
June 19, 1923. 1,459,175

F. ALDENDORFF

TELEPHONE EXCHANGE SYSTEM

Filed Dec. 31, 1914 11 sheets-sheet 1

Fig. 1.



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TELEPHONE EXCHANGE SYSTEM

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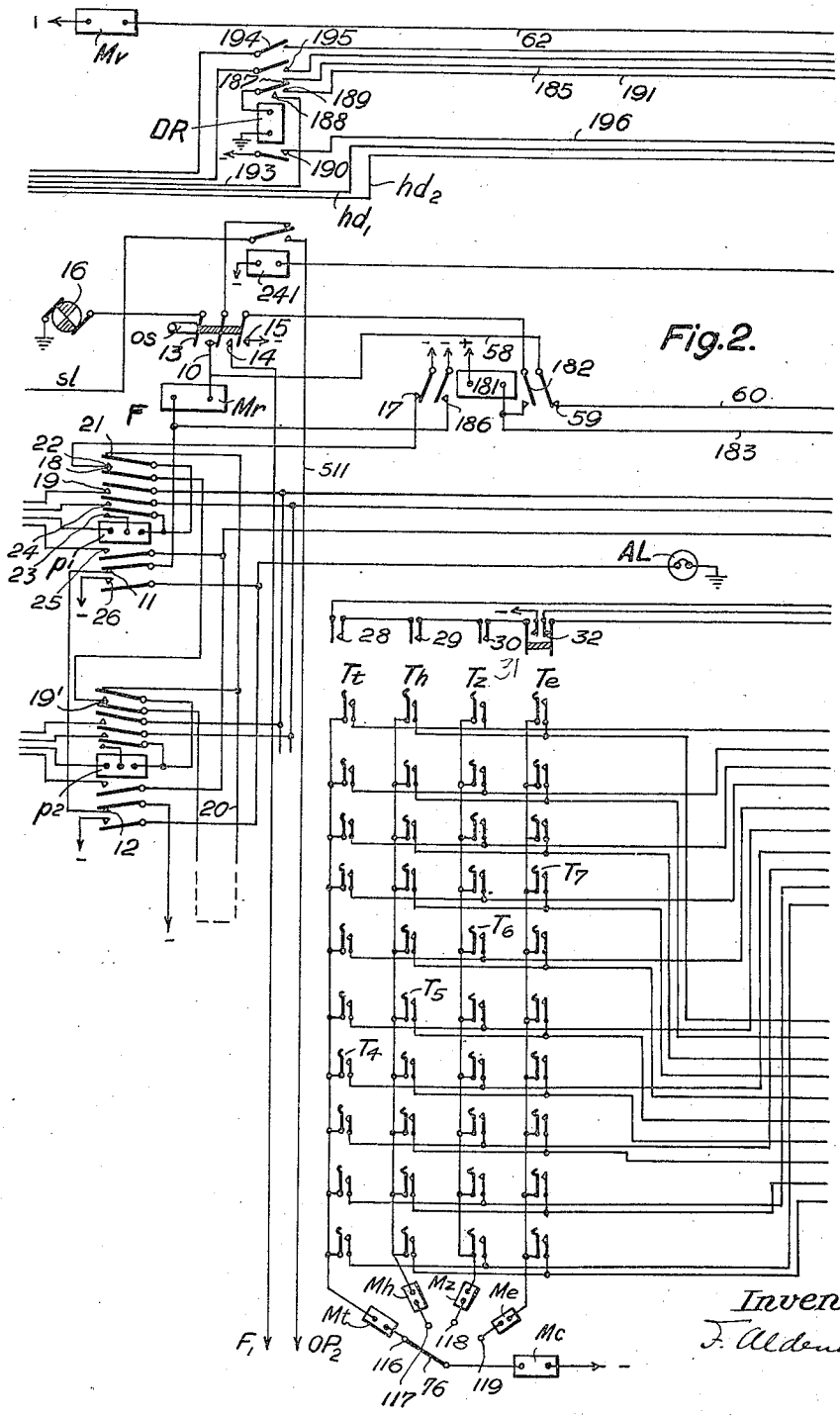

Fig.2.

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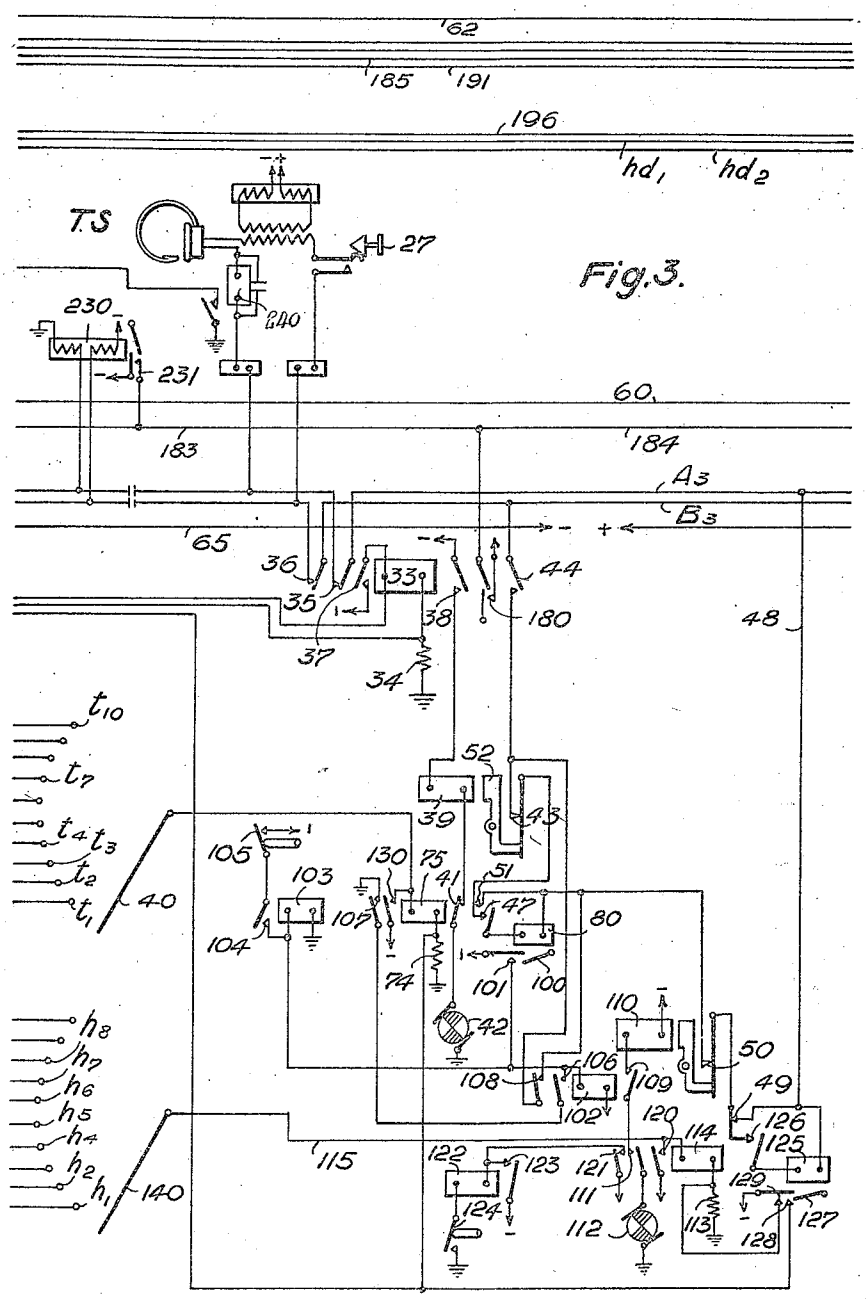

Fig.3.

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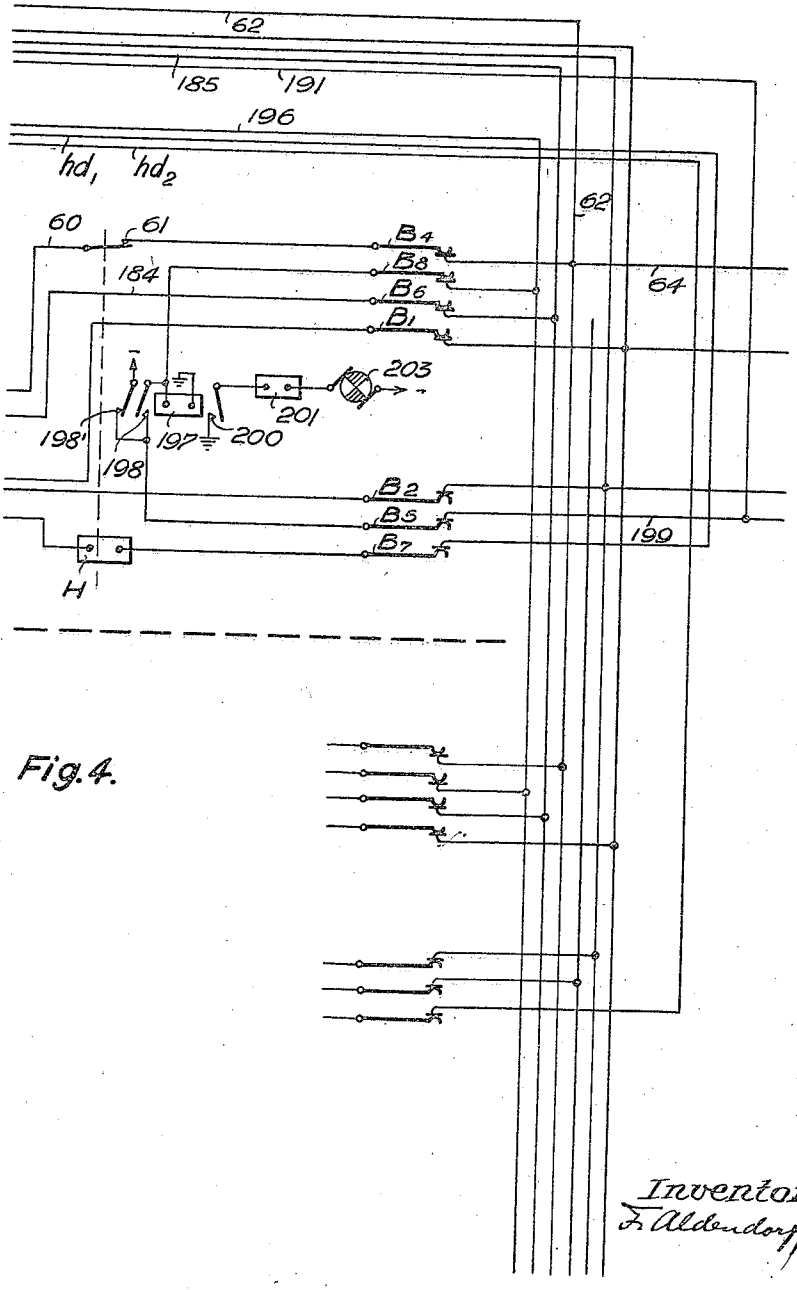

Fig. 4.

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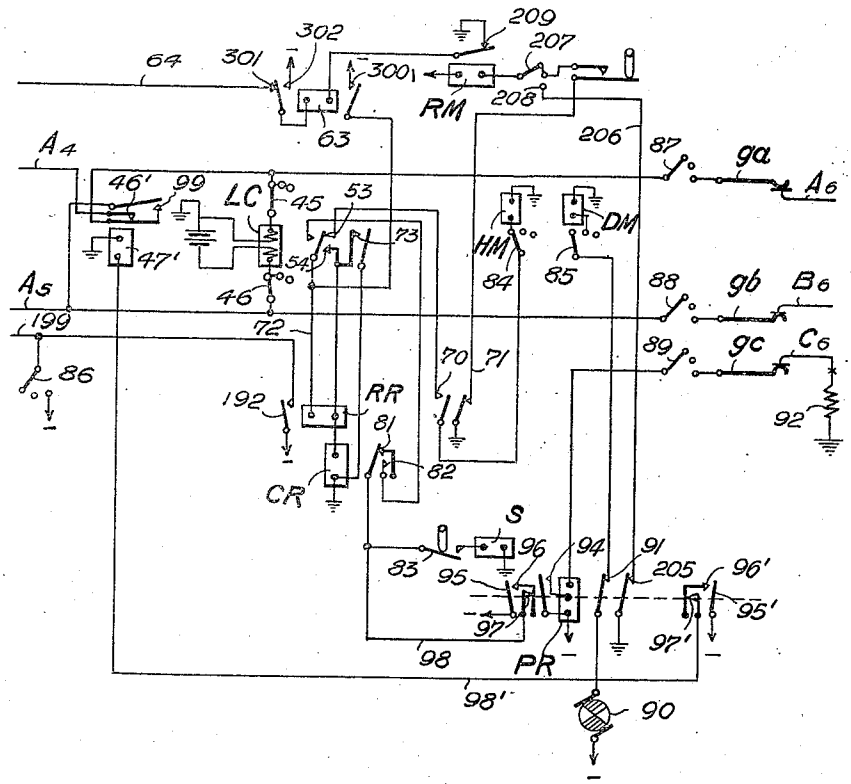

Fig. 5.

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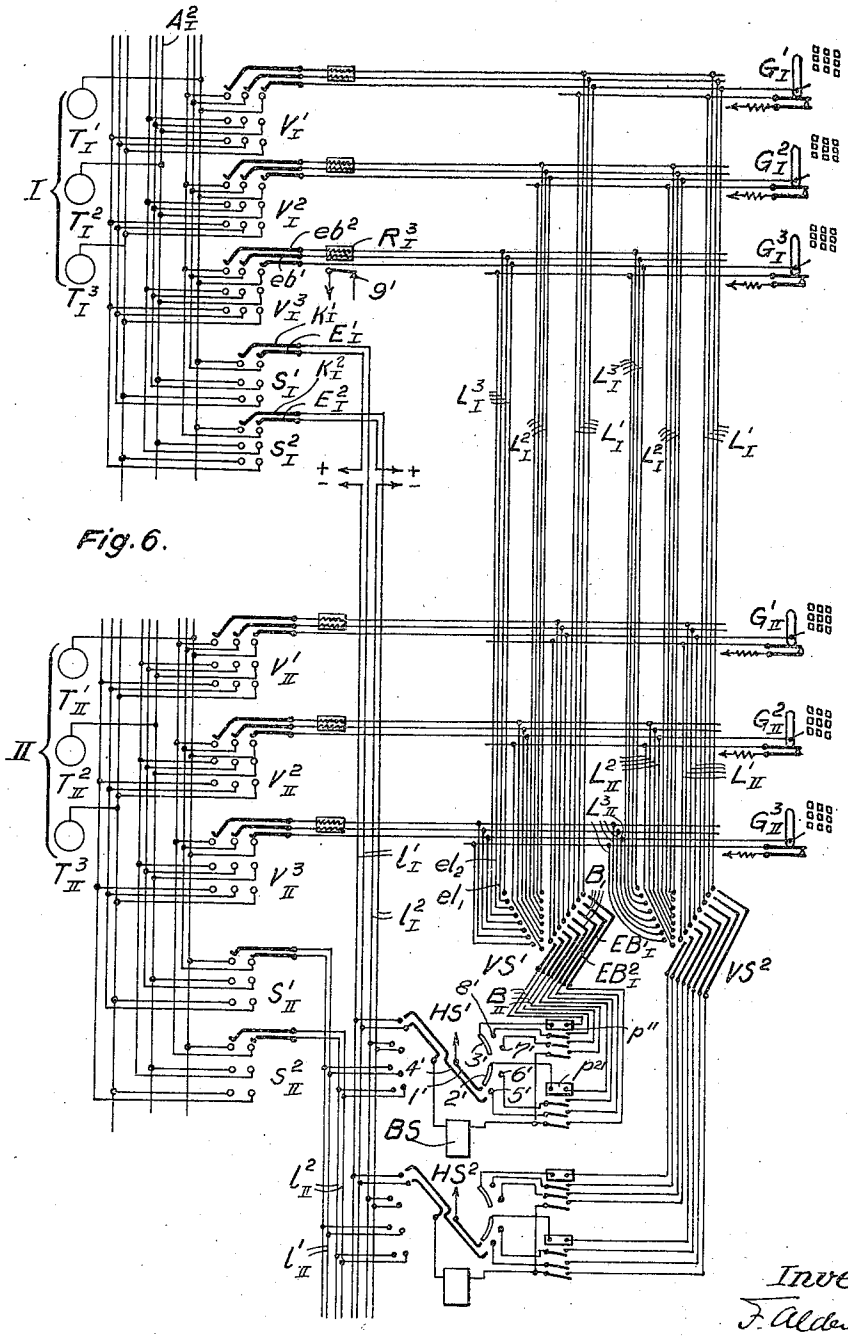

Fig. 6.

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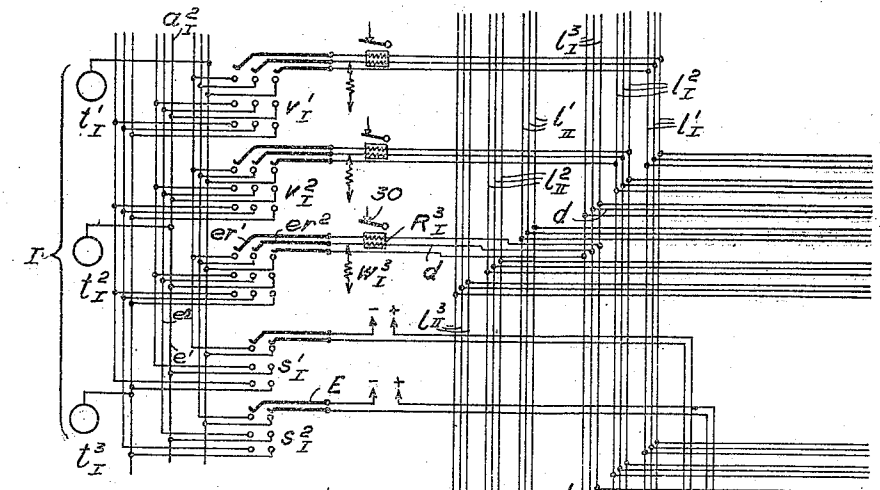

Fig. 8.

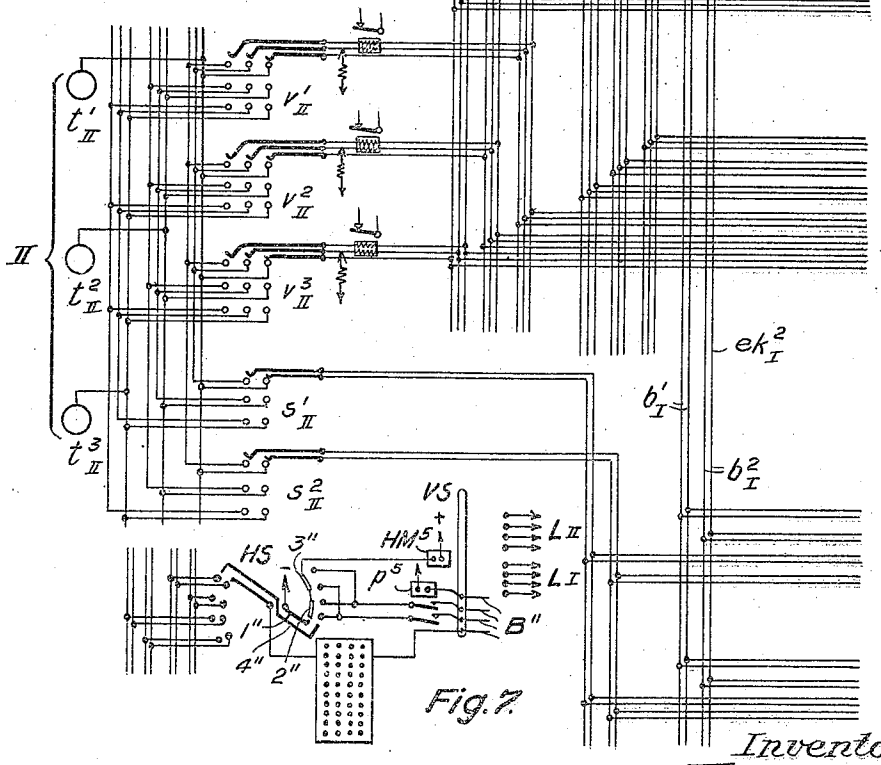

Fig. 7.

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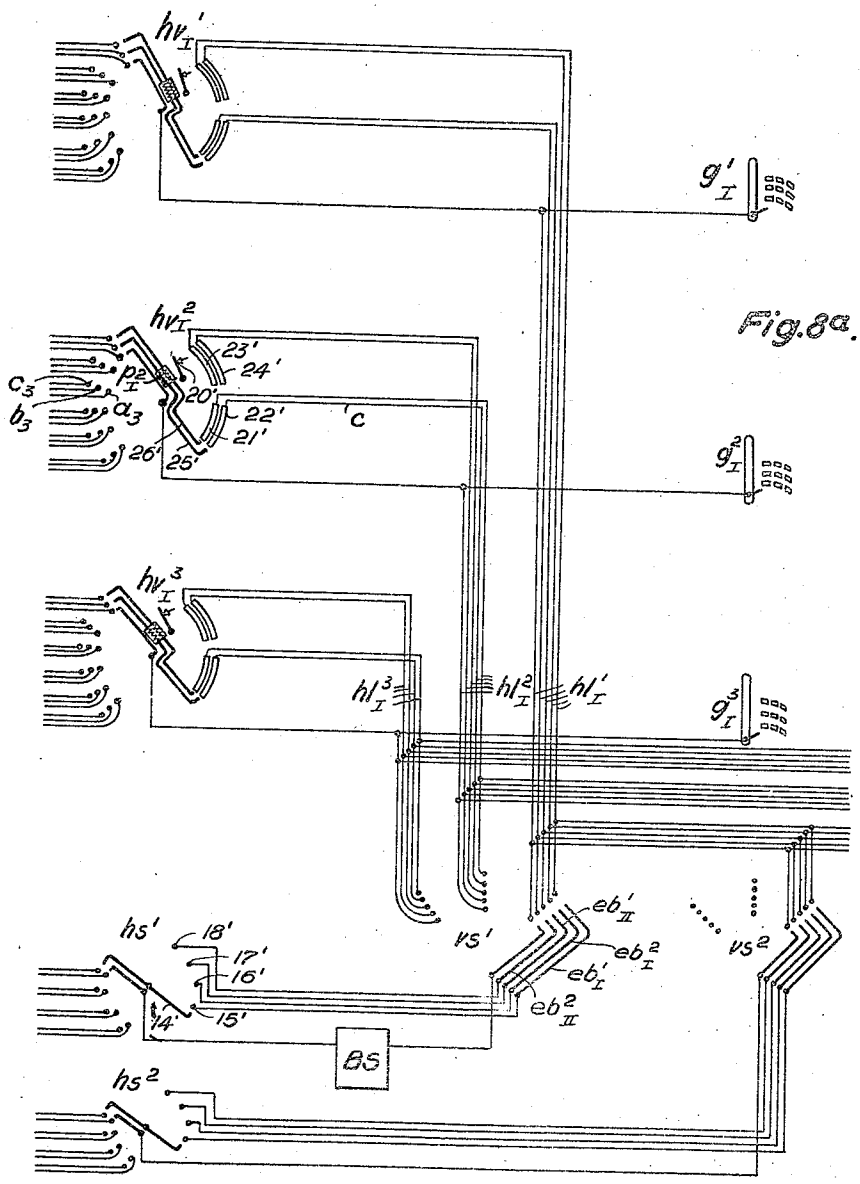

Fig. 8a.

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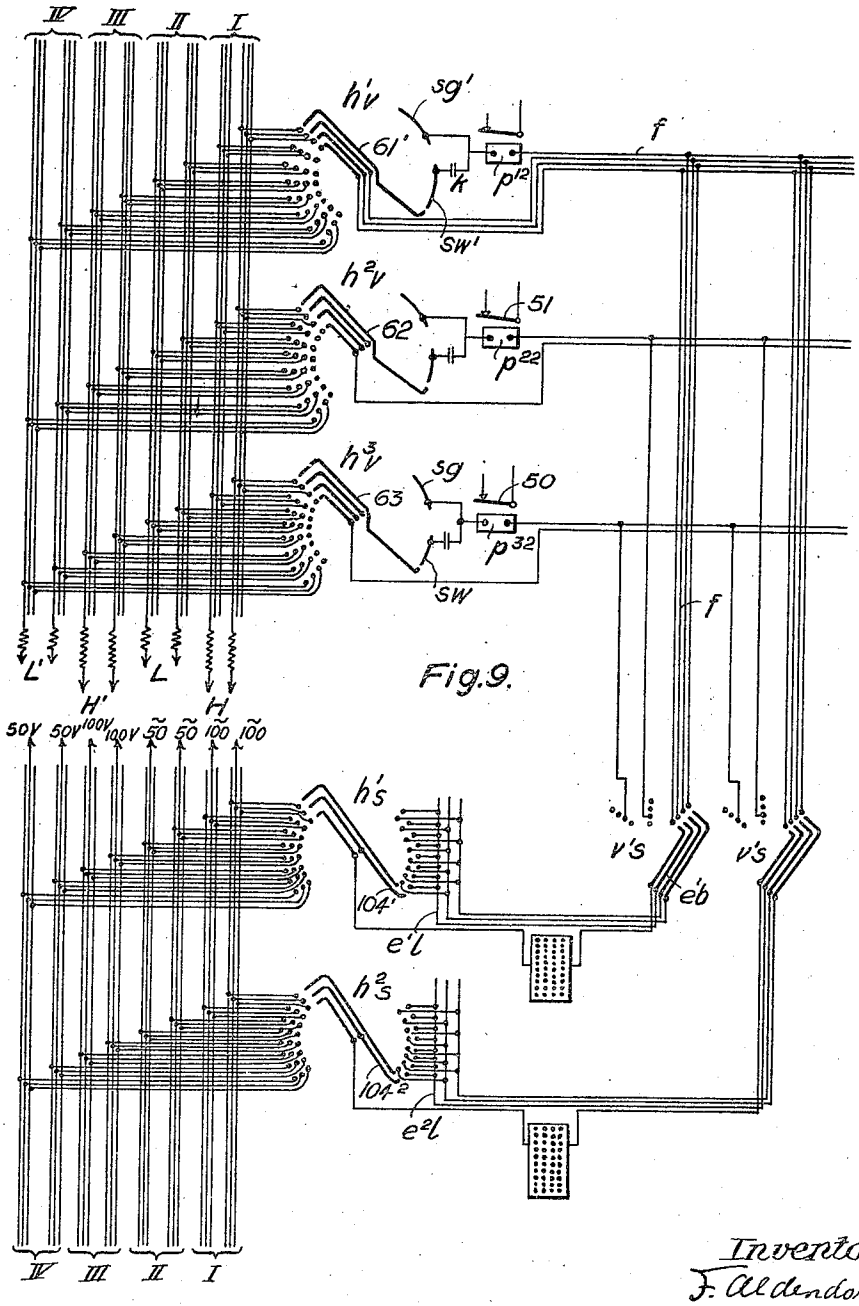

Fig.9.

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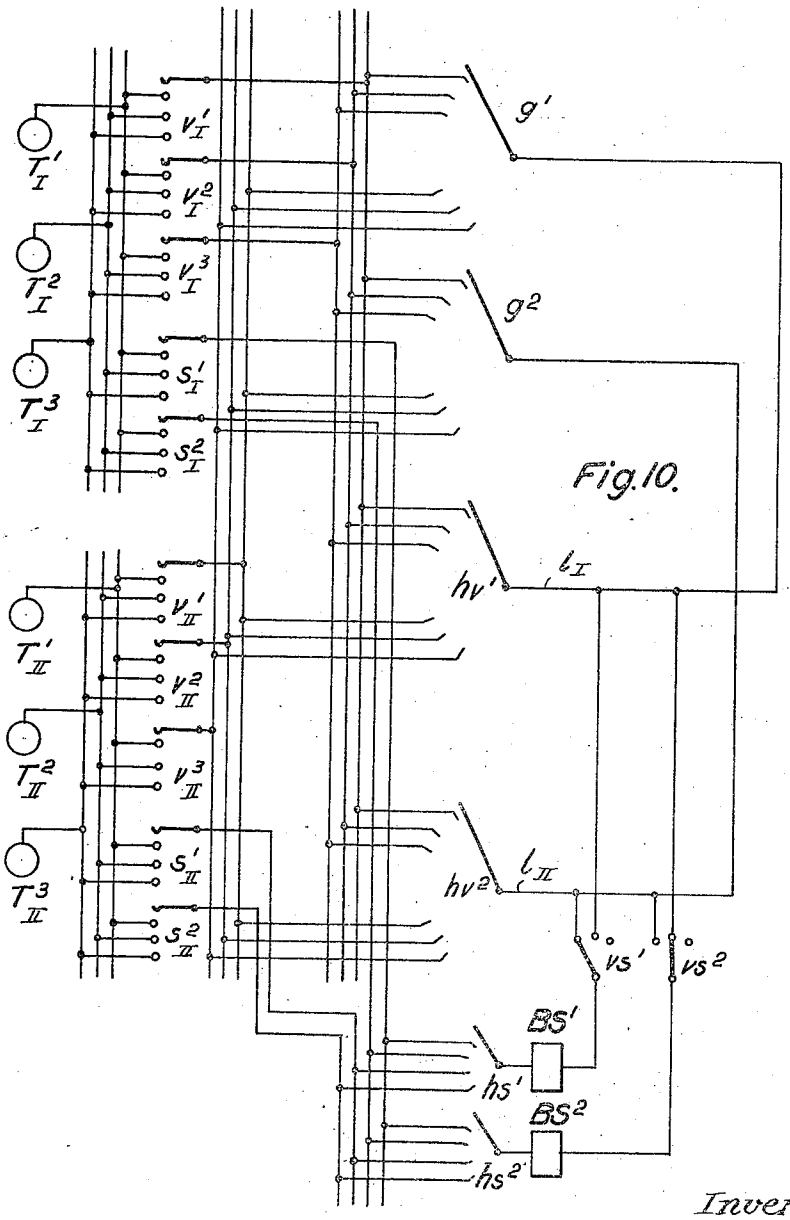

Fig.10.

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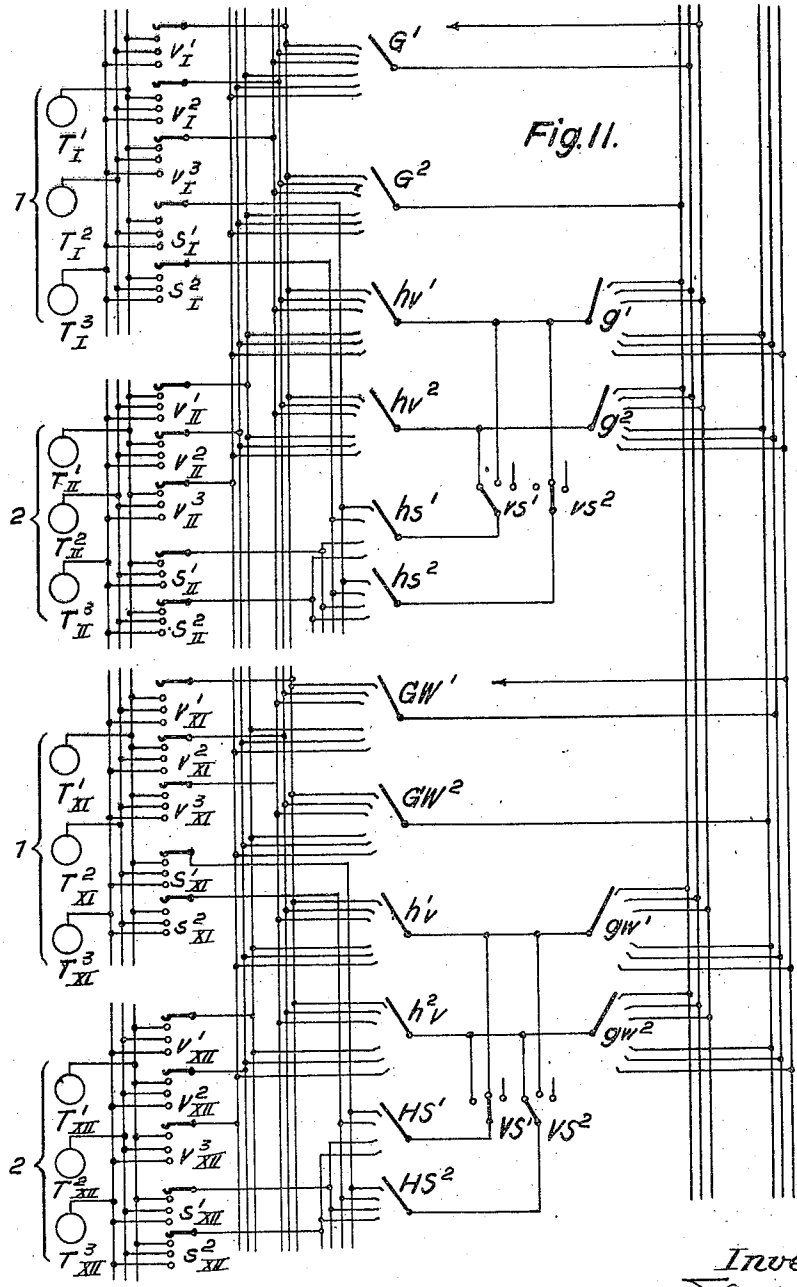

Fig. 11.

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Patented June 19, 1923. 1,459,175

UNITED STATES PATENT OFFICE.

FRITZ ALDENDORFF, OF BERLIN-WILMERSDORF, GERMANY.

TELEPHONE-EXCHANGE SYSTEM.

Application filed December 31, 1914. Serial No. 879,950.

(GRANTED UNDER THE PROVISIONS OF THE ACT OF MARCH 3, 1921, 41 STAT. L., 1313.)

To all whom it may concern:

Be it known that I, FRITZ ALDENDORFF, of 32 Mannheimerstrasse, Berlin-Wilmersdorf, Germany, have invented new and useful Improvements in Telephone-Exchange Systems (for which I have filed applications in Germany, Jan. 20, 1914; England, Jan. 10, 1914; Germany, March 9, 1914; England, April 1, 1914; and Russia, April 16, 1914), of which the following is a specification.

This invention relates in general to improvements in telephone exchange systems in which the connections are established through electromechanically controlled switches.

A feature of the invention consists in the one end of a link circuit containing an operator's switch controller being automatically connected to a free slow-acting finder and to a free selector associated therewith whenever the switch controller by its controlling currents has caused a switch or set of switches to establish a connection with a wanted line, whilst the other end of the said link circuit is automatically connected to a subscriber's line as soon as the subscriber calls.

Each connection between two subscribers is first established through a relatively quick-acting switch or finder. The quick-acting finder is in one link circuit extending between a calling line and a selector, and the slow-acting finder is in another link circuit between the said line and selector. The moment a connection through the link circuit containing the quick-acting finder has been established between two subscribers this link circuit is disconnected from the established connection and connected to another idle selector.

The quick-acting finders are each provided with several simultaneously-operating test brushes the number of which is greater than that of the test brushes on the slow-acting finders. When a subscriber calls the next idle quick-acting finder in the group of switches to which he belongs is started by a current impulse produced by the line relay of the calling subscriber. This current impulse flows through a contact of the cut-off relay of the calling subscriber. When the cut-off relay is energized the said starting impulse circuit is opened and the flowing of a wrong starting impulse on the deenergization of the line relay is thus prevented.

The operator's switch controllers in the new system each consist of two impulse counting brushes. Associated with each brush is a relay the operation of which is made dependent on the testing and change over functions of the selectors controlled by the switch controller. The moment one of these relays is caused to operate as a result of a testing or change over function, it starts the operation of the next impulse counting brush that is due to act. The said relays are switched into the controlling circuit extending from the operator's controller to the selectors before the testing or change over functions in these selectors take place. The moment one of these functions is performed the part of the controlling circuit extending from the selector to the controller is momentarily opened by a device in the selector. By this means the relay in the controlling circuit at the controller is momentarily deenergized and this momentary deenergization of the relay results in the operation of the impulse counting brush in the controller being started that counts the impulses in the next series of selector controlling impulses.

Another feature of the invention consists in a novel arrangement of the starting circuit of the operators' finders. Usually this starting circuit is extended in a known manner to the next idle finder the moment a finder is taken into use. The new feature consists in the starting circuit which leads to the quick-acting finder of a certain operator being extended, when this operator connects herself to a calling line, straight to the finders of another operator.

An advantage obtained by using quick-acting finders with several test brushes in the operators' link circuits and relatively slow-acting finders in link circuits through which

the talking circuit is maintained is that large groups of subscribers may be formed without making calling subscribers wait more than a second or so before the operator responds. The broad idea of using link circuits with quick-acting finders with several simultaneously testing arms to establish a preliminary connection, that is afterwards replaced by a link circuit with a slower acting finder having fewer test brushes, may be used with equal advantage both in full automatic and semi-automatic exchanges.

Another feature of this invention is directed to the means for causing a secondary link circuit, to which a primary link circuit that takes up a call is connected, to be connected without fail by its connecting switch to no other line but the particular calling line to which the said primary link circuit has been connected. It is clear, that in a practical exchange several calls will originate at times in various groups simultaneously and in each group several calls may be sent in at practically the same moment. An identifying means is provided which enables a secondary link circuit to identify the group of lines from which it took a call and also the line in that group from which the call proceeded. If no such means were provided, wrong connections would be obtained by calling subscribers, for the call sent in by a subscriber and passed on by a primary link circuit to a certain secondary link circuit represents a certain wanted number, and if the secondary link circuit were to be connected to a second calling subscriber, the result would be that the second calling subscriber would be connected through group and final selectors to the called line that is wanted by the first subscriber.

The identifying means consist in a special identifying circuit for each primary link circuit being provided in the secondary link circuits or in the switches belonging to the secondary link circuits through which the established talking connections are maintained. Another feature of the invention consists in an arrangement of the secondary link circuits by which the connection switches, that connect the secondary link circuits directly to the subscribers' lines, may be used both for incoming calls and for outgoing calls or in other words for extending a calling subscriber's line to a group selector and at other times for extending a connection from a group selector to a wanted subscriber's line.

The invention will now be explained by the aid of the accompanying drawings.

The invention is illustrated in the accompanying drawing. A complete diagram is obtained by placing Figs. 1, 2, 3, 4 and 5 beside each other. Fig. 1 shows the subscribers' lines with their relays, the brushes of the quick-acting finders and of the slow-acting finders, and the multiple connections of the subscribers to the bank contacts of the said finders. Fig. 2 illustrates the relays and electro-magnets of the slow-acting and quick-acting finders and the keyboard of an operator's switch controller. In Fig. 3 the other devices belonging to the switch controller are shown. Fig. 4 represents a trunk finder and Fig. 5 a group selector.

Fig. 6 shows a method of applying the invention in which the primary link circuits of each comprising an operator's keyboard B.S. are connected to the lines of calling subscribers by two finders H.S. and S in tandem whenever a subscriber calls. The finder H.S. by its operation in connecting to a calling line in a certain group causes its associated selector finder V.S. to pick out the group from which the call was received and to connect to a free secondary link circuit L in that group. The group selector G and the slow acting finder V belonging to the free secondary link circuit may then be operated simultaneously the group selector extending the connection from the secondary link circuit towards the wanted subscriber and the slow acting finder extending the connection from the link circuit towards the calling subscriber.

Fig. 7 illustrates a modification of the selector finders VS of Fig. 6.

Figs. 8 and 8[a] when placed side by side show another way of applying the invention. Here the primary link circuits each extending between a switch *hs* and a switch VS are always immediately connected by their selector finders VS^1, VS^2 to a free secondary link circuit *hl* the moment they are disconnected from an engaged secondary link circuit. The primary link circuits are connected to calling lines by means of two switches *hs* and *s*, and the secondary link circuits are also connected to the calling lines by two switches *hv* and V in tandem.

When a call comes through from any particular group e. g. group I to a primary link circuit this primary link circuit will already be connected by its selector finder e. g. VS^1 to a free secondary link circuit e. g. hl^2_I and the auxiliary slow finder hv^2_I will be immediately started. It will first select the group I from whence the call came and will then pick out a free multiple wire e. g. l^3_1 leading to an idle slow-acting finder V^3_I. This finder will then be caused to select the calling line. During the time in which the connection is being extended from the seized secondary link circuit hl^2_I to or towards the calling subscriber it will also be extended through the group selector g^2_1 and through the further selectors to or towards the wanted subscriber.

This method of extending a connection from a middle point through a number of

selectors towards both the calling and called subscriber also forms a feature of this invention.

Fig. 9 shows a method by which the number of brushes required on the selector finders VS can be diminished in number.

Fig. 10 shows how the auxiliary slow finders *hv* and the group selectors *g* of an exchange may both be connected to the multiples leading to the slow acting finders V. In a case like this the slow acting finders are provided with means which cause them to act as final selectors whenever a call is extended to them through a group selector *g*.

Fig. 11 illustrates an application of the switching method shown in Fig. 10 to an exchange in which there are minor groups each consisting of a plurality of small groups 1, 2 and major groups each comprising a plurality of minor groups. This indicates how the principle consisting in extending a connection from a middle point through a number of selectors towards both the calling and called subscribers disclosed in Figs. 5 to 9 may be applied to systems of any size.

In Fig. 1 S_2, S_{14} indicate two subscribers' stations whilst TR_2, LR_2 and TR_{14}, LR_{14} are the cut-off and line relays belonging to these stations. Station S2 for example is connected by lines A2, B2, C2 to sets of bank contacts in the slow-acting and quick-acting finders. All the other subscribers in the same group are connected in a similar manner to corresponding sets of bank contacts in the quick-acting and slow-acting finders.

The slow-acting finders each have a set of brushes *va*, *vb*, *vc*, *vd*, *ve* that is moved by means of a motor magnet M*v* over sets of fixed bank contacts. The quick-acting finders F are each provided with several sets of brushes, e. g. 10, all of which are moved together over sets of bank contacts by a motor magnet M*r*. By means of its several sets of brushes each quick-acting finder hunts in several sub-groups of subscribers' lines simultaneously for a calling line, so that if ten sets of brushes such as, *a*1, *b*1, *c*1, *d*1 and *a*2, *b*2, *c*2, *d*2 are used, the quick-acting finder needs only to travel the distance covered by ten contact sets in order to pick a calling line out of a hundred lines. Each brush set *a*1, *b*1, *c*1, *d*1 or *a*2, *b*2, *c*2, *d*2 has a test relay *p*1 or *p*2, which is energized when its set of brushes reaches a calling line and then connects the calling line to a link circuit or operator's position. A calling lamp AL is then lighted on the operator's position whereupon the operator answers the call. Having obtained the number of the desired line the operator writes down this number on the keyboard by depressing a thousands, hundreds, tens and units key. The switch controller thereupon commences sending selecting impulses to the selectors in the exchange and these selectors establish a connection with the wanted subscriber. When this connection is made a second connection is established over another path comprising a slow-acting finder, which meanwhile has hunted and found the calling line, and the first connection comprising the quick-acting finder F and the trunk finder Fig. 4 is disrupted, and the trunk finder immediately connects the quick-acting finder to another idle selector Fig. 5.

The operation of all the circuits will now be described in detail.

When a subscriber e. g. S2 makes a call a current flows from the negative pole of the exchange battery through LR2, 1, *s*1, S2, *s*2, 2, to earth. The line relay LR2 is thus energized and closes its contact 3 which connects earth to the test wire C2 of the calling line by way of 3, 8, TR2. Electrical "calling potential" is thus applied to the test contacts in the quick-acting and slow-acting finders.

The line relay LR2 operates on its energization the contact springs 4, 5, 6. The spring 4 is pressed against spring 5 and this spring is then moved away from spring 6. By this means a current impulse is sent from earth through 7, 4, 5, 6, starting wire *s*1, contact 10, of an off-normal switch OS of the next idle quick-acting finder F in the group, motor magnet M*r*, contacts 11, 12 of the test relays of the quick-acting finder to the negative pole. As soon as the spring 5 leaves the spring 6 this impulse through the motor magnet M*r* ceases and the armature of the motor magnet in falling back then moves the brush sets of the quick-acting finder out of their normal position. The moment the brush sets of the quick-acting finder are moved out of their normal position the off-normal switch OS is shifted and its contacts 13, 14, 15 are closed whilst its contact 10 is opened. By the opening of contact 10 and the simultaneous closure of contact 14 the starting wire *sl* is disconnected from the quick-acting finder F and extended to the next quick-acting finder F1 belonging to the next link circuit. By the closure of contact 13 an interrupter 16 is connected to the motor magnet M*r* and impulses then flow from the earth through 16, 13, M*r*, contacts 11, 12 the negative pole and these impulses cause the magnet M*r* to move the brush sets of the quick-acting finder over the bank contacts connected to the subscribers' lines. The moment a set of brushes e. g. *a*1, *b*1, *c*1, *d*1 reaches a set of bank contacts e. g. *pa*, *pb*, *pc*, *pd*, that belongs to a calling line, a current flows from the negative pole of the battery through 17, contacts 18, 19^1 of the various test relays, common battery lead 20 to the contact 21 of the test relay whose brush *c*1 has reached the calling

line, winding of test relay *p*1, *c*1, *pc*, C2, cut-off relay TR2 contact 8, 3 to the earth. The cut-off relay TR2 is energized and closes through a contact 9 a locking circuit for itself that is independent of the contact 3. At the same time the cut-off relay disconnects the line relay from the calling line by opening the contacts 1 and 2. In order to prevent the momentary connection between the contact springs 4, 5, and 6, which takes place when the armature of the line relay drops back, from causing another impulse to be sent through the starting wire *sl* and thereby starting another quick-acting finder F1, the connection between the contact spring 4 and earth is broken at contact 7 when the cut-off relay is energized.

The test relay *pl* that is energized in the quick-acting finder in the manner described above disconnects itself from the common battery lead 20 leading to all the test relays *p* in that finder and switches itself at 22 into an independent circuit. By opening its contact 18 the test relay *pl* cuts off the battery feed to all the other test relays on the same finder. By closing its contact 23 it short circuits a part of its winding and thus lowers the potential of the calling line causing it to appear engaged. By closing its contact 25 it prepares a circuit which soon afterwards causes a slow-acting finder LV to set its brushes onto the particular calling line A2, B2, C2 that the quick-acting finder F has sought out. Finally the test relay *pl* closes by its contact 26 the circuit of a calling lamp AL and through its contacts 19 and 24 it extends the calling line *s*1, *s*2 to the position of an operator. The operator observing the lighting of the calling lamp AL depresses her listening key 27 and thus connects her talking apparatus TS to the calling line. After ascertaining the number of the wanted line, which will be assumed to be No. 4567, she depresses the keys T_4, T_5, T_6, T_7 and these keys are held in their depressed positions in a known manner by locking bars (not shown). A separate locking bar is provided for each row of keys and each locking bar controls a contact that is individual to the particular row of keys. Thus the locking bar of the row of thousands keys controls a contact 28, the locking bars of the hundreds, tens and units rows control contacts 29, 30 and 31 respectively. The locking bar of the units row controls an additional contact 32. When a key in each row is depressed the contacts 28, 29, 30 and 31 are closed and thereby a relay 33 is energized by a current that flows from earth through a resistance 34, relay 33, 28, 29, 30, 31 to the negative pole. The relay 33 closes a locking circuit for itself through its contact 37, which circuit is independent of the contacts 28, 29, 30 and 31. By opening its contacts 35, 36 it disconnects the calling line from the link circuit A3, B3 leading to the selectors and by closing a contact 38 it completes the circuit of a motor magnet 39 which moves an impulse counting brush 40 over a set of contacts *t*1—*t*10. Each of these contacts are connected to keys in the thousands row T_t and tens row T_z.

Current impulses now flow from the negative battery pole through 38, 39, 41, 42 to earth. At each impulse the magnet 39 moves the impulse counting brush 40 one step forward and at the same time it opens a contact 43.

It is to be observed that the relay 33 when energized closed at its contact 44 the circuit of a selector controlling relay LC which is located in a group selector Fig. 5. This circuit may be traced from earth through the upper winding of the relay LC, side switch 45, contact 46^1 of a relay 47^1, line A4, brush B1 of the trunk finder, line A3, 48, 49, 50, 51, 43, 44, B3, B2, A5 side switch 46, lower winding of the relay LC to the other pole of the battery. Each attraction of the armature 52 results in this controlling circuit being opened and in the controlling relay LC closing its contacts 53 and 54.

Before tracing any further the course of the connection through the group selectors and the final selector, the events will now be described that take place (simultaneously with the events in the quick-acting finder) in the slow-acting finder LV1 that is associated with the group selector Fig. 5.

The starting impulse that is sent when a subscriber calls through the starting wire *sl* flows not only through the motor magnet *Mr* as already described but also through the wire 58, contact 59, wire 60, contact 61, brush B4, wire 62, motor magnet *Mv* of the slow-acting finder LV1 to earth.

When this starting impulse through the motor magnet *Mr* ceases the off normal switch OS is shifted as previously described and the impulser 16 is connected to the magnet *Mv* of the slow-acting finder as well as to the magnet *Mr*. Current impulses then flow from the earth through 16, 13, 58, 59, 60, 61, B4, 62, *Mv* to the negative pole and the motor magnet *Mv* moves the brush set *va*, *vb*, *dc*, *vd*, *ve*, over the sets of bank contacts belonging to the calling subscribers. The moment the set of bank contacts is reached, which corresponds to the set of contacts upon which the brush set of the quick-acting finder F is resting, a current flows from the negative pole through the wire 65, contact 25 of the test relay *pl*, brush *dl*, contact *pd*, wire D2, contact *dv*, brush *vd*, stopping wire *hd*1, brush B7 of the trunk finder Fig. 4, stopping relay H to the positive pole of the battery. The stopping relay H opens the contact 61 and thus stops the operation of the motor magnet *Mv* so that the brush set of the slow acting finder stops on the set

of bank contact which belongs to the calling line. A talking connection is not, however, established through the brushes of the slow-acting finder until the connecting relay DR is energized and this energization only takes place after all the group selectors and the final selector used for the connection have completed their operations.

The events in the establishing of a connection through the selectors under the influence of a switch controller have been described up to the point where the circuit of the magnet 39 was closed and the operation of the impulse counting brush 40 commenced. At each step that the counting brush 40 is caused to take the contact 43 is opened and the controlling circuit containing the controlling relay LC of the group selector interrupted. At each interruption the controlling relay LC closes a contact 53 and causes a selecting impulse to flow from the negative pole through the contact 300 of a relay 63, 53, 70, vertical magnet HM of the selector which for example may be assumed to be of the Strowger type.

It is to be observed that the relay 63, was energized by the starting impulse that flowed through the brush B4 and the wire 62 and a portion of which went through 64, 301, 63 to earth, causing the relay 63 to switch itself into an independent locking circuit which includes the contacts 302 and 209.

The release relay RR is energized as soon as the controlling relay LC is energized in the manner described above. The current through the release relay flows from the negative pole of the battery through 300, 72, RR, contact 73 to earth. At each detraction of the armature of LC an impulse will therefore flow through the vertical magnet HM which lifts the brushes *ga*, *gb*, *gc* of the group selector. When the counting brush 40 of the operator's controller reaches the contact *t*4 that is connected to the depressed key T4 a current flows from the earth through the resistance 74, a relay 75, 40, *t*4, T4, magnet *Mt*, contact arm 76, magnet *Mc* to the negative pole of the battery. When this impulse ceases the magnet *Mt* releases the locking bar of the row of thousands keys and the magnet *Mc* shifts the contact arm 76 to its next contact 117. The relay 75 opens the circuit of the motor magnet 39 at contact 41 so that the interruptions of the contact 43 and the impulses caused thereby in the controlling circuit A3, B3 cease. At the same time the relay 75 closes a contact 47 and opens the contact 51. This results in a relay 80 being included in the controlling circuit. The current through this relay flows from the earth through LC, 45, A4, B1, A3, 48, 49, 50, 80, 47, 43, 44, B3, B2, A5, 46, LC back to the battery. The relay LC now keeps its armature attracted long enough to cause the change over relay CR, which is short-circuited during the attraction of LC, to let its armature drop back and to close the circuit of the side switch magnet S at contacts 81, 82. This circuit may be traced from the earth through S, 83, 81, 82, 300 to the negative battery pole. The side switch magnet thereupon shifts the side switches 45, 46, 84, 85, 86, 87, 88, 89, 207 into their second positions which results in the closure of the circuit of the rotary magnet DM of the group selector by the side switch 85. This circuit extends from the negative pole of the battery through the impulser 90, contact 91, of the test relay PR, DM to earth. The rotary magnet now turns the brushes *ga*, *gb*, *gc* causing them to brush over the sets of bank contacts (that are each connected to a trunk A6, B6, C6) until a trunk leading to an idle second selector in the wanted thousand ground is found. The moment the test brush *gc* reaches the test contact of an idle trunk a current flows from the negative battery pole through the test relay PR, 89, *gc*, to test wire C6 and through a contact 93 and a resistance 92 in an idle second group selector. The test relay PR is energized and opens the circuit of the rotary magnet at its contacts 91. At its contact 94 the test relay short circuits a part of its winding thus lowering the potential on the test wire C6 and making the trunk A6, B6, C6 appear engaged. The test relay also causes the contact spring 95 to be pressed against a contact spring 96 which latter is thus moved away from another contact 97. By this action of the springs 95, 96, 97 and similar springs 95^1, 96^1, 97^1, wires 98 and 98^1 are momentarily connected to the negative pole of the battery and this results in current impulses being sent simultaneously through the side switch magnet S and a relay 47′. The side switch magnet moves the contact arms of the side switch into their third positions which results in the circuit A4, A5 being extended through 87, 88 to the next selector and the controlling relay LC being disconnected from the leads to the operator's controller. The wires A4, A5 are extended to the next group selector by the switches 87, 88 before the controlling relay LC of the group selector Fig. 5 is disconnected, so that the no interruption of the controlling circuit or of the current flowing through the relay 80 takes place when the controlling circuit is extended. But the relay 47′ short circuits the controlling circuit by its contact 99 and opens by its contact 46^1 the current path extending through A4, B1, 48, 49, 50, 80, 47, 43, 44, B3, B2, A4 which results in the deenergization of the relay 80 of the controller. The armature 100 of this relay in travelling back momentarily closes a contact 101 by which the restoring magnet 103 of the counting brush 40 and also a relay 102 is energized. The restoring mag-

net 103 closes its armature contact 104 and thus switches itself into a locking circuit which extends from the negative pole through the contact 105, 104, 103 to earth. The contact 105 is an off-normal contact that is closed as soon as the counting brush 40 is moved out of its normal position. The moment the counting brush after being released by the magnet 103, reaches its normal position, the contact 105 is opened and the locking circuit of the magnet 103 is broken.

When the relay 102 is energized as described it closes a locking circuit for itself through the contacts 106 and 107 and it also closes a shunt about the contacts 43 and 51 by its contact 108. At the same time it closes by its contact 109 the circuit of the motor magnet of the counting brush 140. In this circuit current impulses flow from the earth through the impulser 122, 111, 109, 110 to the negative battery pole. At each impulse the magnet 110 moves the counting brush 140 onto another contact in the contact set *h*1—*h*10.

The relay 47′ in the group selector Fig. 5 will meanwhile have allowed its amature to drop back so as to reestablish the controlling circuit by its contact 46. Therefore the interruptions of the contact 50, the number of which corresponds to the number of steps of the counting brush 140, will act upon the controlling relay in the second group selector similarly as they influenced the controlling relay LC of the group selector Fig. 5. As soon as the counting brush 140 has been advanced to the contact *h*5, that is connected to the depressed hundreds key T5, a current flows from the earth through the resistance 113, relay 114, 115, 140, *h*5, T5, magnet M*h*, contact 117, contact arm 76, magnet M*c*, to the negative pole. The relay 114 is then energized and switches itself into a locking circuit through closing its contact 120. At the same time it opens the circuit of the magnet 110 at its contact 111 and closes the circuit of the restoring magnet 122 at its contact 121. The restoring magnet is thus energized and restores the counting brush 140 to its normal position. Whilst the counting brush is travelling back to its normal position the restoring magnet is kept energized by a locking circuit which includes the contacts 123, 124 and which is opened at the contact 124 when the counting brush 140 regains its normal position.

The relay 114 also closes the contact 126 and opens a contact 49 and thereby introduces a relay 125 into the selector controlling circuit. The relay 125 is then immediately energized by a current flowing from the second group selector and through the controlling loop similarly as the relay 80 was energized by a current flowing through the controlling relay LC of the first group selector Fig. 5 and through the controlling circuit.

By the interruptions of the contact 50 the second group selector will now have been raised to the level of bank contacts that leads to the final selectors in the wanted hundred group. During the interval of steady closure of the contact 50 which ensues after the transmission of the selecting impulses the second group selector is caused to change over in a known manner from the selecting to the trunk hunting function. The moment a free trunk is found a relay in the second group selector, which is similar to the relay 47′, Fig. 5 opens the portion of the controlling circuit that extends to the operator's switch controller so that the relay 125 in the controller is deenergized. The armature of this relay then falls back and in so doing momentarily closes the contacts 128, 129, which short circuits the relays 75 and 114 and thus deenergized them. The relay 75 then closes the contact 41 and thus causes a renewed operation of the counting brush 40 by the motor magnet 39. It also opens the circuit of the relay 102.

The counting brush 40 is now stepped forward a second time and the third series of impulses is sent over the controlling circuit by the interruption of the contact 43. The motion of the counting brush 40 and the interruptions of 43 continue until the counting brush reaches a contact *t*6 that is connected to the depressed tens key T6 when a current flows from the earth through 74, 75, 40, *t*6, T6, M*z*, 118, 76 to the negative battery pole. The relay 75 then deenergizes the magnet 39 and introduces the relay 80 into the controlling circuit in the manner already described. The controlling circuit is then kept steadily closed and this causes the "change over" to take place in the final selector from the vertical to the horizontal rotary movement. The final selectors are arranged so that at the moment the change over takes place a relay similar to 47′, Fig. 5 is momentarily energized so as to cause a brief opening of the part of the controlling circuit that extends back to the operator's controller. By this opening of the controlling circuit the armature 100 is caused to fall back so as to momentarily close a contact 101 and this results in the counting brush 40 being restored by the restoring magnet 103 and in the energization of the relay 102 in the manner already described. The relay 102 remains energized until the relay 75, is deprived of its locking current by the resistance 74 being short-circuited, the said locking current flowing through the contact 130. The energization of the relay 102 results in the closure of the circuit of the motor magnet 110. The motor magnet then receives impulses from the impulser 112 and

moves the counting brush 140 over the contacts *h*1—*h*10 a second time. At each step taken by the counting brush 140 the controlling circuit is interrupted at contact 50 and at each interruption the brushes of the final selector are rotated one step in a known manner. When the counting brush 140 reaches the contact *h*7 that is connected to the depressed units key T7 a current flows from earth through 113, 114, 115, 140, *h*7, T7. *Me*, 119, *Mc* to the negative battery pole. The relay 114 opens the circuit of the motor magnet 110 and closes the circuit of the restoring magnet 122 by its contact 121 thus causing the counting brush 140 to be restored to its normal position. The current impulse that flows through the counting brush 140 and through T7, *Me*, *Mc*, causes the contact arm 76 to be shifted from the contact 119 to 116 so that this arm will now have regained its normal position. In the movement of the contact arm 76 from the contact 116 to the contacts 117, 118, 119, and back to 116 the magnets *Mt*, *Mh*, *Mz*, *Mc* each received a current impulse and each of these magnets shifted a separate locking bar (not shown) and thereby released the depressed key in its row in a well known manner. It also restored the special contacts such as 28 associated with its row of keys. Therefore when all the depressed keys T4, T5, T6, T7 are released the special contacts 28, 29, 30, 31 will all be opened and the contact 32, closed. By the closure of the contact 32 of the row of units keys the circuit for stopping the operation of the operator's switch controller is prepared. The stoppage of the controller is caused by the opening of contact 38 i. e. by the deenergization of the relay 33 and this relay is deenergized when the contact 32 is closed and the relay 125 allows its armature 127 to fall back.

When the relay 114 is energized (after the units impulses that cause the rotary movement of the final selector have been sent) and the counting arm 140 is restored and the contact 32 closed, it closes the contact 126 whilst opening the contact 49. By this means the relay 114 introduces the relay 125 into the controlling circuit that extends from the final selector. After the final selector has been moved by the units impulses produced by the contact 50 onto the desired subscriber's line and the operation of contact 50 has been caused to cease by the energization of the relay 114 the controlling circuit extending from the final selector is closed for an appreciable length of time through the relay 125 in the same way as this took place after the operation of the second group selector. After a certain interval the final selector then changes over in a known manner from the units selecting function to testing the wanted line and in so doing causes a relay which is similar to relay 47', Fig. 5 to open the part of the controlling circuit that extends to the switch controller. This results in the deenergization of the relay 125 and in the detraction of the armature 127 which in falling back momentarily closes the contacts 127, 128 and deenergizes the relays 114, 75 and 33 by short-circuiting them. Of course these relays might just as well be deenergized by the armature 127 opening their circuits instead of short circuiting them. The deenergization of relay 33 results in the opening of the circuit of the magnet 39 so that a renewed operation of this magnet and of the contact 43 will not take place when the armature contact 41 is closed by the deenergization of the relay 75. When the armature of the relay 75 falls back the locking circuit of the relay 102 is opened at 107 so that after the final detraction of the armature 127 all the parts of the operator's controller will be in their normal position.

When the armature of the relay 33 falls back the contact 180 is momentarily closed and the relays 181 and DR, Fig. 2 are thus energized. The former causes the quick-acting finder to be restored to its normal position and the latter connects the calling subscriber to the called subscriber through the brushes of the slow-acting finder and through the group selectors and final selector.

The circuit of the relay 181 may be traced from the negative pole through 180, 183, 181 to the positive pole. This relay opens at its contact 17 the battery lead to the test relays *p*1, *p*2, etc., and thus prevent a test relay from being energized during the restoration of the finder if a test brush *c* should strike upon the earthed contact of a calling line. By its contact 186 the relay 181 closes the circuit of the motor magnet *Mr* (earth, 16, 13, *Mr*, 186, negative pole) and by its contact 182 it closes a locking circuit for itself which remains closed until the motor magnet *Mr* has moved the finder back into its normal position and has thus shifted the off-normal switch so as to open the contact 15 and break the circuits of the relay 181 and of the magnet *Mr*.

The current that energized the relay DR flows from the negative pole through 180, 184, B6, 185, 187, DR to earth. The relay DR closes a locking circuit through its contact 189 (earth, DR, 189, 191, 86, or 192, negative pole) and also establishes a circuit through the cut-off relay TR2 of the calling subscriber S2 this circuit extending from the negative pole through 192 or 86, 191, 189, 188, 193, *vc*, C2, TR2, 9 to earth. In this way the negative pole is directly connected to the test wire C2 and the potential on the test wire is lowered to zero so that no test relay *p* in any finder F will be energized when brought into connection with this wire. This condition of the wire C2 is main-

tained until the relay DR is deenergized at the end of the connection between the calling and called subscriber.

The relay DR in addition to connecting the calling subscriber's line to the called line through its contacts 194, 195 also produces a starting impulse for the trunk finder Fig. 4. This starting impulse flows from the negative pole through 190, 196, B8, starting relay 197 to earth. The relay 197 closes its contact 198 and thus completes a new circuit through B5, 199, 86 to the negative pole. By its contact 200 it closes the circuit of the motor magnet 201 which circuit extends from earth through 200, 201, impulser 203 to the negative pole. The motor magnet now moves the brushes B1, B2, B4, B5, B6, B7, B8 of the trunk finder over sets of bank contacts leading to slow-acting finders and group selectors until an idle selector is found. The wire 199 of each busy selector will be connected to the negative pole either through a contact 86 or 192 or through the contact 198 of another trunk finder Fig. 4 that is already connected to the particular trunk. As long as the brush B5 encounters wires 199 thus connected to the negative pole, the relay 197 is kept energized and the circuit of the motor magnet 201 remains closed at contact 200 so that the rotation of the brushes of the trunk finder will continue until the test brush B5 strikes upon an idle test wire 199 i. e. a test wire that is not connected to the negative battery pole. As soon as this happens the relay 197 lets its armature 200 drop back opens the circuit of the motor magnet 201 and at the same time connects the negative pole to a wire 199 through its contact 198^1. The one end of the link circuit A3, B3 containing the operator's switch controller will then be connected to a new free trunk and the other end of this link circuit will be ready to be connected to another calling line by its quick-acting finder F.

At the finish of the talking connection the slow-acting finder LV1, the group selectors and the final selectors are released in any suitable known manner and a contact at 93, Fig. 5 will then be opened. This results in the deenergization of the test relay PR and in the closure of the contact 205. The release magnet RM of the first group selector will then be energized (earth 205, 206, 208, RM, negative pole) which causes the group selector to be released and the locking circuit of the relay 63 to be opened. By the release of the selector the side switch is moved back into its normal position and the negative battery pole will be disconnected by the switch arm 86 from the wire 191 so that the connecting relay DR and the cut-off relay TR2 of the calling line will be deenergized. The slow acting finder LV1 has no normal position and its brushes remain where they stand at the end of a connection until the finder is used in a fresh call.

In case a subscriber calls and only talks to the operator without having a connection set up through the selectors, the quick-acting finder used for the call is restored by a relay 230, Fig. 3 which is energized by a current that flows to the calling subscriber as soon as the quick-acting finder makes the connection. When the subscriber replaces his receiver in a case like this, the falling back of the armature of relay 230 causes the momentary closure of a contact 231 and thus momentarily connects the negative pole to the wire 183. This energizes the relay 181 and this relay then causes the quick-acting finder F to be restored in the manner previously described.

In order to prevent an operator from receiving more calls than she is able to handle expeditiously through several of her quick-acting finders being set onto calling lines a relay 240 is included in her talking circuit which is energized whenever she depresses her listening key 27. The relay 240 then causes the starting wire *sl* to be connected directly to an extension wire *s*11 that leads straight to the quick-acting finders of the next operator's position OP2. This function may be performed by the relay 240 itself or by the aid of another relay 241.

An advantage obtained by using quick-acting finders to connect the calling subscribers to the operators' positions is that relatively large groups of subscribers may be formed and in spite of this the calls of subscribers will still be quickly passed on to idle operators. It is well known that by forming large groups of subscribers a better trunking efficiency is obtained. If groups of two hundred subscribers are formed fifteen to seventeen slow-acting finders per group and three or four quick-acting finders with their switch controllers and trunk finders would generally give good service.

Although the slow-acting finders shown in the drawing have only one hunting brush *vc* it is evident that several simultaneously hunting brushes *vc* and brush sets *ba*, *vb*, *vd*, *ve* may be provided. But it will generally be preferable to have more sets of brushes on the finders F than on the finders LV.

In Fig. 6 two groups (I and II) of subscribers T^1_I, T^2_I, T^3_I, and T^1_{II}, T^2_{II}, T^3_{II} are shown. The lines of the subscribers that extend from their stations T to the exchange are connected in multiple to the fixed contacts of all the quick-acting finders S and all the slow-acting finders V of the particular group. The line of subscriber T^2_I for example is thus multiply connected by taps or branches from the wire A^2_I. In addition to the wire or wires connected to the line extending to each subscriber's station local

wires are provided at the exchange for each subscriber's line, each of these local wires being connected in multiple to fixed contacts of the slow-acting finders V of the particular group, but being connected to only one of the quick-acting finders S of that group. For example the subscriber T^2_I has two local wires e^1, e^2. The wire e^1 is connected to a fixed contact in the middle contact row of each slow-acting finder V. The wire e^2 is connected to a fixed contact in the left hand contact row of each slow-acting finder V. But the wire e^1 is connected only to one quick-acting finder S^1_I and the wire e^2 only to the quick-acting finder S^2_I. These wires form a part of the identifying means by which the slow-acting finders are enabled to identify the line from which the call proceeded that set them in action. The slow-acting finders each have one identifying brush for each set of identifying wires. There is an identifying brush eb^1 for the wires connected to the quick-acting finder S^1_I and another brush eb^2 for the wires connected to the quick-acting finder S^2_I. The quick-acting finders, however, have only one brush each (E^1_I on S^1_I and E^2_I on S^2_I) that travels over the contacts of identifying wires.

The auxiliary quick-acting finders HS each have an identifying brush or pair of brushes 4^1 and a group selecting brush 1^1 which causes the corresponding selector-finder VS to select the proper calling group.

When a subscriber e. g. T^2_I removes his receiver from the hook in starting a call an idle quick-acting finder e. g. S^2_I rapidly moves its brushes onto the contacts of the calling line. The moment the finder S^2_I starts moving the idle auxiliary quick-finders HS or one of them will be started searching for the wires l^2_I leading to the finder S^2_I and will stop when the contacts of these wires are reached. We will assume that the connection to the wires l^2_I is made by the auxiliary quick-finder HS^1. The calling subscriber T^2_I will then be connected through his line wire A^2_I, S^2_I, l^2_I, brushes of HS^1 to the primary link circuit. If the exchange is a semi-automatic one this link circuit will include the keyboard BS of an operator.

According as the call comes from group I or group II the brush 1^1 of the auxiliary quick-finder will stop on a contact segment 2^1 or 3^1 and will thus connect the battery to a test relay p^{21} or p^{11}. If the call comes from group I, as assumed in the present case, the test relay p^{21} will thus be rendered active and the selector finder VS^1, which starts moving its brushes as soon as the auxiliary finder stops, will hunt for a free secondary link circuit amongst the link circuits L^1_I, L^2_I, L^3_I belonging to the first group I. If the call had come from the second group II the brush I^1 of the auxiliary quick-finder would have stopped on the segment 3^1 and would have rendered the second test relay p^{11} active. This would have resulted in the selector finder VS^1 confining its testing action to the secondary link circuits L^1_{II}, L^2_{II}, L^3_{II} of the second group.

When the selector finder VS^1 finds an idle secondary link circuit e. g. L^3_I the test relay p^{21} is energized and closes its contacts. It thus connects two brushes EB^1_I, EB^2_I of the identifying circuits, to the contacts 5′ and 6′. According as the call came through the quick-acting finder S^1_I or S^2_I the brush 4^1 of the auxiliary quick-finder HS^1 will be resting on 5^1 or 6^1. In the case assumed the brush 4^1 will be resting on 6^1 and therefore battery will be connected from the negative pole through a wire of l^2_I and through 4^1, 6^1 to the identifying brush EB^2_I only, the other brush EB^1_I being dead. The battery connection to EB^2_I extends to $el2$ and to the upper winding of the relay R^3_I which controls the stopping of the slow-acting finder V^3_I that belongs to the secondary link circuit L^3_I which was seized by the selector finder VS^1. Thus only the upper winding of the relay R^3_I whose brush $eb2$ travels over the contacts of identifying wires such as $e2$ leading to the quick-acting finder S^2_I is active.

If the call had been extended to HS^1 through the other quick-acting finder S^1_I only the lower winding of R^3_I and the corresponding brush $eb1$ that travels over the identifying wires leading to S^1_I would have been rendered active, because the brush 4^1 of HS^1 would then have stopped on contact 5^1.

An energizing circuit for R^3_I is closed when the brush $eb2$ reaches the contact that is connected to the wire $e2$ upon which the quick-acting finder S^2_I that took the call is resting. It will not be possible for an energizing circuit for R^3_I to be closed by the brush $eb2$ on any other wire because the wire $e2$ can only be connected to the positive pole of the battery by the brush E^2_I of S^2_I and not by any other quick-acting finder S^1_I. When the brush $eb2$ of V^3_I, which is started moving as soon as the secondary link circuit L^3_I is seized, reaches the contact of the wire $e2$, with which the brush E^2_I made connection, an energizing circuit including the upper winding of R^3_I is closed. This circuit may be traced from the negative pole of the exchange battery through the left wire l^2_I, pair of brushes 4^1, 6^1, EB2, $e12$, upper winding of R^3_I, upper brush $eb2$, $e2$, brush E^2_I, to the positive pole of the battery. The stopping relay R^3_I immediately opens its contact 9^1 and thus opens the circuit of the power device (not shown) that drives the brushes of V^3_I. During the time in which the slow-acting finder is travelling towards the contacts of the calling line, the operator may be setting up the other end of

the connection through the group selector G^3_I and any other selectors that may be interposed between the seized secondary link circuit and the wanted subscriber. It will be noticed that the selector finders VS have a separate set of brushes BI, BII for each group of calling lines. This can be avoided and a single set of brushes provided in the manner shown in Fig. 7. When the brushes of the auxiliary quick-finder HS of Fig. 7 rotate in search of a line leading to a quick-acting finder the brush l^{11} wipes past segments 2'', 3 that are connected to the lifting magnet HM^5 of an up-and-around selector VS, Fig. 7. By this means a number of current impulses are sent through the magnet HM^5 that corresponds with the calling group. Thus if group I is calling the magnet HM^5 will receive one impulse, if group II is calling two impulses will flow through HM^5 and lift the brushes B^{11} to the secondary link circuits LII that lead to slow-acting finders of the second calling group. The operation of the identifying brush 4^{11} and the circuits co-operating therewith is the same as in Fig. 6 so that no further explanation of Fig. 7 is necessary.

In the Figs. 8 and 8^a, which are to be placed side by side, an application of the identifying means is shown in a system in which the selector finders VS do not execute any movement when a call is received or taken up by a primary link circuit. The selecting of the proper calling group and of an idle slow-acting finder in that group is performed by auxiliary selectors *hv*, which are interposed between the slow-acting finders V and the group selectors *g*.

When a subscriber e. g. t^2_I calls, an idle quick-acting finder, e. g. S^2_I, extends the calling line to the contacts of auxiliary quick-finders *hs* and an idle one of these takes up the call and thus connects the calling subscriber t^2_I with an idle primary link circuit. The moment the auxiliary quick-finder e. g. hs^1 stops, the operator will ask for the wanted number and she can immediately start the selecting operations of a group selector e. g. g^2_I, to which the primary link circuit will already be connected by the corresponding selector finder *vs*1. Another operation also takes place immediately the auxiliary quick-finder stops and this is the starting of the auxiliary selector hv^2_I that belongs to the secondary link circuit hl^2_I to which the selector finder *vs*1 has been supposed to have connected. It will be supposed that the stopping of the motion of the auxiliary selector is controlled by the opening of a contact 20^1 of a relay p^2_I. The coils of this relay are in circuits that pass through pairs of segments 21^1, 22^1—23^1, 24^1 and a corresponding pair of brushes 25^1, 26^1. According as the call has come from the subscriber in one group or another group a segment of the one pair 21^1, 22^1 or of the other pair 23^1, 24^1 will be connected to the exchange battery, and according as the call was taken up in the calling group by the one quick-acting finding S^1_I or the other quick-acting finder S^2_I the one segment 22^1 or the other segment 21^1 of the pair 21^1, 22^1 or the one segment 24^1 or the other segment 23^1 of the pair 23^1, 24^1 will be connected to the exchange battery. The battery is connected to the proper segment 21^1, 22^1, 23^1 or 24^1 by the brush 14^1 of the auxiliary quick-acting finder. If the auxiliary quick-finder hs_1 stops on either one of the lines b^1_I, b^2_I that leads to a quick-acting finder of the first calling group, the contact 15^1 or 16^1 will be connected through 14^1 and a wire of b^1_I or b^2_I to the positive pole of the battery. The contacts 15^1 and 16^1 are connected through the brushes eb^1_I, eb^2_I and through two wires of hl^2_I to the two segments 21', 22'. Therefore if the auxiliary quick-finder hs^1 makes connection with the second quick-acting finder S^2_I of the first calling group the brush 14^1 will rest on contact 16^1 and the segment 22^1 of the auxiliary selector will be connected to battery. The other segments 21^1, 23^1, 24^1 will be dead. The relay p^2_I which controls the stopping of the auxiliary selector hv^2_I will therefore only be active whilst the brush 25^1 is travelling over the segment 22^1. If no segment 21^1 or 22^1 were connected to battery i. e. if the call had come from the second calling group II the relay P^2_I would not become active until the brushes 25^1, 26^1 of the auxiliary selector reach the segments 23^1, 24^1. In this way the auxiliary selector is caused to select the group from which the call came and to commence hunting only after the trunks leading to slow-acting finders in that group have been reached. In the case assumed the call is supposed to have come from the first group I and the segment 22 is connected to battery because the call was taken up in the first group by the second quick-acting finder S^2_I. If the call had been taken up by the first quick-acting finder S^1_I the other segment 21^1 would have been connected to the battery. Thus only the lower winding of p^2_I is active. This lower winding is energized as soon as an idle trunk l^1_I, l^2_I or l^3_I leading to the calling group is found. It will be assumed that idle trunks are characterized by a negative potential connected to them through a resistance such as w^3_I and that l^3_I is the first idle one struck by the brushes of hv^2_I. The moment this trunk is reached a current will flow through the lower winding of p^2_I this current passing from the positive pole, through ek^2_I, 14^1, 16^1, eb^2_I, *c*, 21^1, 25, p^2_I, *d* of l^3_I, w^3_I to the negative pole. The relay p^2_I is energized and stops the motion of the brushes of hv^2_I by opening its contact 20. The circuit

just traced may also be caused to start the motion of the brushes of the slow-acting finder V^3_I, to disconnect the resistance w^3_I and the negative battery pole and to cause the trunk l^3_I to appear engaged.

The stopping of the slow-acting finder V^3_I may be accomplished by a relay R^3_I being caused to open a contact 30 the moment the subscriber's line is reached that originated the call. The upper or lower winding of the relay R^3_I will be active according as the call was taken up by the first quick-acting finder S^1_I or the second quick-acting finder S^2_I or according as the brush 14 of the auxiliary quick-finder hs^1 has stopped on the contact 15 or 16. Thus in the case assumed only the lower winding is active and the brushes of V^3_I continue to move until the lower brush $er2$ reaches the wire $e2$ upon the contact of which the brush E of the second quick-acting finder is resting. The bottom winding of the relay R^3_I then receives sufficient current to energize the relay to open the contact 30 and stop the switch V^3_I with its brushes resting on the line from which it took the call. During the time in which the auxiliary selector hv^2_I and the slow-acting finder are executing their movements, the selectors which extend the connection from the secondary link circuit hl^2_I to the wanted line may be operated under the direction of a switch controller in an operator's position or at the calling subscriber's station. The moment the connection between the wanted line and the calling line is established the selector finder vs^1 is caused to connect its primary link circuit to another idle secondary link circuit e. g. hl^3_I.

For the method of applying the invention shown in Figs. 8 and 8^a a separate set of wires is required for each set of segments on the auxiliary selectors $h.v.$ In Fig. 9 a method is shown by which four wires leading to four different segments are replaced by a single wire connected through a relay p to two segments sg and sw. To the fixed contacts of the auxiliary quick-finders h^1s, h^2s four groups of wires extending from the quick-acting finders of four different calling groups I, II, III, IV are shown. It will be noticed that the battery wires which are connected through the brushes 104 of the auxiliary quick-finders and through e^1l, e^1b to the wires f that lead to the test relays p^{12} to p^{32}, are connected to different current sources. The battery wires of group I are connected to an alternating current of 100 volts, group II to 50 volts alternating, group III to 100 volts continuous and group IV to 50 volts continuous current. Therefore the test relay of the secondary link circuit that takes up the call will be connected to one of these four different kinds of current according to the group that the call proceeded from. We will suppose, for example, that the selector finder V^1S has established a connection with the first secondary link circuit to which the auxiliary selector h^1v belongs, and that the auxiliary quick-finder h^1s takes up a call from the fourth group IV. The brush 104^1 will in this case connect a continuous current of 50 volts to the wire e^1l so that the test relay p^{12} will be connected to 50 volts D. C. When the brushes of h^1v travel over the contacts leading to the trunks which extend to the different calling groups I, II, III, IV the brush 61^1 will connect the relay p^{12} first through a condenser k and segment sw^1 to the test wires of group I. These are connected to the other pole of the current source through high resistances H. The continuous current could not flow through the condenser k in any case so the test relay p^{12} will remain unenergized. This will also ensue when the brush 61^1 traverses the second set of trunks II. When the third set of trunks III is reached the brush 61^1 will ride on the segment $sg1$ and a path will be established for the flow of continuous current. But the resistances H^1 included in the test wires of the third group III are too high to allow the relay p^{12} to be energized by 50 volts, so the brushes of h^1v continue their travel without giving the relay p^{12} a chance to be energized until the fourth group IV is reached, the test wires of which are connected through low resistances L^1 to the other pole of the current source. As soon as a free trunk in this group is reached the relay p^{12} responds and stops the auxiliary selector on a trunk leading to an idle slow-acting finder in the calling group.

If the call taken up by the auxiliary quick finder h^1s were one coming from the third calling group III, 100 volts D. C., would be connected to the test relay p^{12} and it is evident that the auxiliary selector would then commence hunting for a free trunk as soon as the brush 61^1 reached the trunks of the third group III the higher resistances H^1 of which will allow the relay p^{12} to respond if 100 volts D. C. are applied.

If the call taken up by h^1s come from the second group a 50 volt alternating current would be applied to the relay pl and it would commence being active when the second group II of trunks is reached by 61^1, the resistances L in this group being low enough to allow the relay pl to respond to 50 volts. Similarly a call from the first group I would result in 100 volts alternating current being applied to the test relay thus enabling it to respond when the brush 61^1 is travelling over test wires of the first group I that include the high resistances H.

Instead of the calling group selecting means shown in Figs. 8 and 8^a and 9, means similar to those indicated in Fig. 7 would

preferably be used for causing the auxiliary selectors to select the proper calling group.

In Fig. 10 a scheme is shown by which the trunks 1_I, 1_{II}, etc., and the slow-acting finders V of Fig. 8 are not only available for connections between the secondary link circuits and calling lines but also for connections between the secondary link circuits and called lines.

When a subscriber in the system arranged according to Fig. 10 makes a call, his call is taken up by a quick-acting finder S and is extended through an auxiliary quick-finder *hs* to an idle primary link circuit in the same way as described in connection with Figs. 8 and 8ª. An auxiliary calling selector *hv* is then started in its operation of selecting the group from which the call came and simultaneously a group selector *g* is started selecting the group of the wanted subscriber. We will assume that the calling and wanted subscribers are T^1_I and T^2_I respectively. The auxiliary selector, hv^2 for example, would then be caused to select group I and it would make connection with an idle slow-acting finder e. g. V^2_I and this finder would finally make connection with the calling line. Meanwhile the group selector belonging to hv^2 viz. g^2 will also have selected the wanted group, which in this case is in the same calling group, and it will make connection with some other idle slow-acting finder e. g. V^1_I and this finder which now acts as a connector or final selector will be set on to the desired line. Devices are provided in or near the slow-acting finders which effect changes that enable them to act as calling line selectors or called line selectors as the occasion requires.

The system shown in Fig. 10 may be extended for exchanges of larger capacities in various ways. For example further sets of auxiliary quick-finders *hs* may be interposed between the quick-acting switches S and the primary link circuits and further sets of auxiliary or calling group selectors may be interposed between the slow-acting finders and the secondary link circuits. Further sets of wanted group selectors G would then also be interposed between the secondary link circuits and the slow-acting finders V.

Another method is shown in Fig. 11 according to which the connections between the calling subscribers and the primary and secondary link circuits are each made by two sets of switches S and *hs*, and V and *hv*, respectively, in the manner shown in Figs. 8 and 8ª. The first wanted group selectors *g* extend the connections from the secondary link circuits to second wanted group selectors G. The bank contacts of the second wanted group selectors are connected to the same trunks and switches V as the bank contacts of the calling group selectors in the particular major group. The calling group selectors *hv* and the second wanted group selectors extend the connections to idle switches V and through the switches V to the calling and wanted subscribers similarly as the selectors *hv* and *g* of Fig. 10.

I claim:—

1. In a telephone exchange system, a calling subscriber's telephone line, two line finders having movable and stationary contacts, said line terminating at the exchange in stationary contacts of both line finders, an operator's position, a direct connection between the movable contacts of one line finder and said position, a trunk selecting switch individual to said position, a selector switch, stationary and movable contacts for said switches, direct connections between the stationary contacts of said trunk selecting switch and the movable contacts of said selector and the second line finder, a called line terminating in the stationary contacts of said selector switch, means jointly controlled by the calling subscriber and the operator for establishing a temporary connection including only said two line finders and said trunk selecting switch, and means controlled by the operator for establishing a direct connection between the called line and the movable contacts of the second finder.

2. In a telephone exchange system, a plurality of groups of calling lines, called lines, a plurality of groups of transitory links, a plurality of groups of talking links, line finders for extending a calling line belonging to any group to a transitory link belonging to any group, an operator's position associated with the transitory links, selector switches, operator's controlling means for selectively operating said selector switches to extend a talking link towards a called line, selector switches for selecting a talking link by groups and individually, means separate of the operator's controlling means for actuating said last mentioned selector switches, and line finders associated with said talking links, for selecting a calling line by groups and individually.

3. In a telephone exchange system, a plurality of groups of calling lines, called lines, transitory links, groups of talking links leading to calling lines, line finders for extending calling lines to said transitory links, group selectors for selecting a group of talking links, and means associated with said line finders for controlling said group selectors to select a talking link leading to the group of the calling line.

4. In a telephone exchange system, a plurality of groups of calling lines, an operator's position, a selectively operable switching device for extending a line calling in any one of said groups to said position, a plurality of trunk lines, a trunk selector

having two sets of contacts individual to the operator's position, cooperating contacts for said trunk selector in which said trunk lines terminate, means for establishing contact between the two sets of contacts and all the contacts in which said trunks terminate, means responsive to the initiation of a call in one of said groups for rendering effective the connection through one set of contacts, and means responsive to the initiation of a call in another group for rendering effective the connection through the other set of contacts.

5. In a telephone exchange system, a plurality of groups of calling lines, an operator's position, a selectively operable switching device for extending a line calling in any one of said groups to said position, a plurality of trunk lines, a trunk selector having two sets of contacts individual to the operator's position, cooperating contacts for said trunk selector in which said trunk lines terminate, means for establishing contact between the two sets of contacts and all the contacts in which said trunks terminate, means responsive to the initiation of a call in one of said groups for rendering effective the connection through one set of contacts, means responsive to the initiation of a call in another group for rendering effective the connection through the other set of contacts, called lines, switches at both ends of said trunk lines, means for operating the switch at one end of the selected trunk line for selecting the calling line, and means controlled by the operator for actuating the switch at the other end of the trunk line for selecting the called line.

6. In a telephone exchange system, a plurality of groups of calling lines, an operator's position, a selectively operable switching device for extending a line calling in any one of said groups to said position, a plurality of trunk lines, a trunk selector having two sets of contacts individual to the operator's position, cooperating contacts for said trunk selector in which said trunk lines terminate, means for establishing contact between the two sets of contacts and all the contacts in which said trunks terminate, means responsive to the initiation of a call in one of said groups for rendering effective the connection through one set of contacts, means responsive to the initiation of a call in another group for rendering effective the connection through the other set of contacts, called lines, a line finder at one end and a group selector at the other end of each trunk line, means controlled by the operator for actuating said group selector, and means under the joint control of the calling line, switching device and operator for actuating said line finder.

7. In a machine switching telephone system, a source of current, subscribers' lines, operator's link circuits, auxiliary link circuits for connecting the operator's link circuits to calling subscribers' lines, conversational link circuits, means for connecting the conversational link circuits to calling lines, identifying means associated with the said conversational link circuits, means for extending a call from a subscriber's line through an auxiliary circuit to an operator's link circuit and from the operator's link circuit to a conversational link circuit, and identifying circuits through which a current flows only when the said conversational link circuit is connected to the subscriber's line from which the said call proceeded.

8. In a machine switching telephone system, groups of subscribers' lines, primary link circuits, a primary finder with fixed and movable contacts associated with each primary link circuits, auxiliary link circuits extending from the fixed contacts of the said primary finders to different groups of subscribers' lines, auxiliary primary finders in each group of subscribers with movable contacts connected to the auxiliary link circuits and fixed contacts connected to their particular group of subscribers' lines, secondary link circuits, means for connecting the secondary link circuits to subscribers' lines, and means for connecting the primary link circuits to the secondary link circuits.

9. In a telephone exchange system, a calling line, a line and a cut-off relay associated therewith, a trunk, a trunk selector, a line finder for connecting the line with the trunk selector, a line finder for connecting the line with the trunk, electromagnetic operating means for each finder, a circuit for the operating means of the first mentioned finder including a back contact of the cut-off relay and a passing contact of the line relay, and a branch for said circuit including said trunk selector and the operating means of the second mentioned finder.

10. In a machine switching telephone system, subscribers' lines, line finders, line relays, cut-off relays, a source of current, contacts on the line relays for sending a starting impulse to a said line finder while their armatures are moving from the normal to the actuated positions, means for energizing and deenergizing said line relays, and contacts on the cut-off relays for preventing any line relay from sending a starting impulse when it is deenergized.

11. In combination with a machine switching telephone system, subscribers' lines, selector switches, line testing means in the said selectors, operators' switch controllers, a source of current, current impulse producing contacts in the said switch controllers, impulse counters in the switch controllers, series contacts in the said controllers

connected in series with the impulse producing contacts, and relays connected in parallel with the said series contacts, said relays being controlled by the said line testing means and governing the starting of the said impulse counters.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

FRITZ ALDENDORFF.

Witnesses:
HENRY HARPER,
WALDEMAR HAUPT.